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(54) IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF METAL SURFACES

(71) I, AXEL VERNER EISBY, a Subject of the King of Denmark, of Peter Beirholmsvej 6, Kolding, Denmark, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of metal surfaces.

It is known to treat metal surfaces for cleansing purposes by mechanical or chemical means. Flame cleaning processes are also well known for this purpose. Other methods of treating metal surfaces include spark erosion which results in the removal of metal from the surface. To obtain this effect low voltage and high current is employed. It has also been proposed to treat metals to improve the surface adhesion thereof by spark treatment at alternating mains supply frequency using very high voltages, preferably more than 50 KV. The plant for carrying out such latter treatment is both expensive and complicated in view of the high voltages used and the protective screening that is required.

It is an object of the present invention to provide a method for the treatment of metal surfaces to improve the surface adhesion thereof by electric spark discharge which will not impair the surface to be treated and which will avoid the use of high, supply-mains frequency voltages.

According to the present invention there is provided a method for the treatment of metal surfaces to improve the surface adhesion thereof comprising subjecting the surface to an electric spark discharge using a high frequency supply not exceeding 20 Kilohertz and a spark amplitude voltage not exceeding 10 Kilovolts from at least one metal electrode coated with insulation material having a high dielectric constant located at a distance of 0.5 to 2 mm. from the surface to be treated.

According to a preferred feature of the invention one half-wave of the applied high frequency voltage is damped allowing the other half-wave to predominate thereby providing directional control of the spark. In a preferred form of this latter feature the damped half-waves are reduced to about 20 per cent of their undamped voltage excursion.

The method of the invention provides a surface-treatment which is both simple and effective, and which is particularly useful since the relatively low high frequency voltage is not dangerous to the operating personnel. Further, the voltage used has the advantage of achieving millions of spark discharges per unit area of the surface to be treated which gives an even overall effect to the treated surface. Also the sparks can easily be concentrated in sharply restricted fields or areas as the metal electrode may be contoured to suit any surface area desired. The spark discharge treatment is most apparent on pure metals, copper and aluminium for example, and is effective on even the thinnest metal foils without any damage. The treatment lends itself easily to automation and continuous production methods as the high frequency generator of the plant may be started and stopped as often as is required, by means of a simple micro-switch or switches attached to the production machinery. Similarly semi-automatic operation is more easily achieved.

In the case where one or other of the half wave excursions of the applied voltage is damped and the spark direction is made to predominate either towards or away from the surface being treated it is possible either to promote oxidation of the metal surface or to remove excessive oxidation. This predominant spark direction adjustment feature

enables the operator to secure optimum adhesive properties for the surface undergoing treatment.

Specific embodiments of the invention will now be described by way of example.

In the Examples detailed below a high frequency generator was used with a frequency of about 20 kilohertz and a power output of up to 2000 watts, equipped with a high frequency voltage step-up transformer yielding a no-load voltage of 20 kilovolts. Except where otherwise stated the transformer was connected at one terminal to an electrode made of a 2 mm thick metal plate, measuring 500×50 mm. The other terminal of the transformer was connected to earth. The metal electrode was coated with a 1 mm thick layer of insulation material with a dielectric constant of about 7 whereby the effective spark amplitude was about 5—7 kilovolt to the earthed metal surface to be treated.

EXAMPLE 1

The coated metal electrode was moved over an earthed copper plate at a distance of about 1 mm. An intense spark discharge arose between the coated metal electrode and the copper plate. Immediately after the spark discharge treatment the copper plate was sprinkled with an aqueous rubber emulsion containing a dye material and the emulsion was spread evenly on the copper plate. After drying the rubber emulsion adhered tenaciously to the surface of the copper plate whereas a similar piece of copper plate, not exposed to spark discharge, showed the rubber emulsion remaining in drops on the surface and after the drying the rubber emulsion could be removed from the surface by simple rubbing.

EXAMPLE 2

The coated electrode was moved over an earthed aluminium plate at a distance of 1.5 mm. An intense spark discharge arose between the coated electrode and the aluminium plate. After the spark treatment aniline printing ink was spread over the plate. The ink adhered evenly and with a degree of adhesion which was more than three times as great as in the case of an untreated aluminium plate. Also a test with cellulose varnish showed a degree of adhesion on a spark discharge-treated plate which was more than twice as great as that obtained with an untreated plate.

EXAMPLE 3

The secondary winding of the high-frequency voltage step-up transformer was equipped with a diode-resistance-damper partial shunt circuit so that the negative half-waves were at full voltage while the positive half-waves were damped to about 20 per cent of full voltage. A cylindrical metal electrode coated with insulation material was used instead of the electrode mentioned above. The cylindrical metal electrode was provided with distance pieces in the form of rings of insulating material pushed over each end of the cylindrical electrode to ensure a fixed distance between the electrode and the metal surface to be treated. The electrode was rolled over an aluminium plate, and a uniform and powerful spark discharge between the electrode and the aluminium plate occurred. Directly after the treatment a solder connection was made to the plate using an ordinary soldering iron and ordinary soldering material, and essentially improved soldering properties found.

EXAMPLE 4

The apparatus used in Example 3 was again used but with the diode-resistance damper circuit on the transformer omitted. The electrode was rolled over an aluminium foil to be laminated with paper. After the treatment the paper and the aluminium foil could be laminated with only one tenth of the primer normally required for laminating untreated aluminium foil with paper.

EXAMPLE 5

The apparatus used was that described in Example 4. Metal foil was moved under a rotating cylindrical metal electrode and immediately afterwards coated with a melted plastics material. When the plastics material had cooled and hardened, the degree of adhesion between the metal foil and the plastics coating was more than twice as great as in the case of non-treated metal foil.

EXAMPLE 6

The aluminium foil to be treated was carried on a rubber belt conveyor beneath two rotating cylindrical coated electrodes mounted normal to the direction of travel of the conveyor and spaced about 1 mm. above the foil. The electrodes were spaced longitudinally apart along the conveyor and each was coupled respectively to one terminal of one secondary winding of a double secondary wound high frequency voltage step-up transformer. Each secondary winding gave a no-load voltage of 20 KV. The other terminals of the two windings were coupled together. As soon as the foil came under both rotating electrodes an intense spark discharge occurred between the electrodes and the foil. It was found unnecessary to earth the foil as the current path ran through the two windings, the electrodes, each spark discharge and along the foil. The foil so treated was tested in the manner described in Examples 4 and 5 and identical results were observed.

WHAT I CLAIM IS:—

1. A method for the treatment of metal surfaces to improve the surface adhesion thereof comprising subjecting the surface to an electric spark discharge using a high frequency supply not exceeding 20 Kilohertz and a spark amplitude voltage not exceeding 10 Kilovolts from at least one metal electrode coated with insulation material having a high dielectric constant located at a distance of 0.5 to 2 mm. from the surface to be treated.

2. A method as claimed in claim 1 wherein one half-wave of the applied high frequency voltage is damped allowing the other half-wave to predominate thereby providing directional control of the spark.

3. A method as claimed in claim 2 wherein the damped half-waves are reduced to about 20 per cent of their undamped half-wave voltage excursion.

4. A method as claimed in any preceding claim wherein the metal surface to be treated is earthed.

5. A method as claimed in any of claims 1 to 3 wherein two coated electrodes are used spaced apart and fed with high frequency voltage in antiphase relation to each other.

6. A method as claimed in claim 5 wherein the electrodes are substantially parallel to one another and the material to be surface treated is fed past the electrodes seratim at a distance of about 1 mm from each coated electrode.

7. A method as claimed in any preceding claim wherein the coated electrode is or electrodes are cylindrical.

8. A method as claimed in claim 7 wherein the electrode is or electrodes are rotated.

9. A method for the surface treatment of metals as described in any of the foregoing Examples.

10. A method for the surface treatment of metals substantiatlly as hereinbefore described.

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